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EXAMINER

UHLIR, NIKOLAS J

ART UNIT PAPER NUMBER

1773

DATE MAILED: 10/15/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/765,970

Applicant(s)

LEE ET AL.

Examiner

Nikolas J. Uhler

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-18 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-18 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 29 January 2004 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. ____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|--|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date ____ | 6) <input type="checkbox"/> Other: ____ |

DETAILED ACTION

Priority

1. Receipt is acknowledged of papers submitted under 35 U.S.C. 119(a)-(d), which papers have been placed of record in the file.

Drawings

2. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description: The specification on page 9 describes figure "2a." However, there is only one drawing in figure 2. Thus, either a drawing is missing or the notation in the specification is incorrect. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

3. The examiner notes that should the notation in the specification be in error, this objection will be overcome by amending the specification to recite "figure 2," instead of "figure 2a" in the specification.

Specification

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4. 35 U.S.C. 112, first paragraph, requires the specification to be written in "full, clear, concise, and exact terms." The specification is replete with terms which are not clear, concise and exact. The specification should be revised carefully in order to comply with 35 U.S.C. 112, first paragraph. Examples of some unclear, inexact or verbose terms used in the specification are: The term "semi-ferromagnetic" is repeatedly used throughout the specification. This term is not known in the art and is not defined by the specification. Whatever "semi-ferromagnetic" may mean, the examiner knows that the alloys listed as "semi-ferromagnetic" alloy in the specification, i.e. IrMn, FeMn, and NiMn are *anti-ferromagnetic*. Anti-ferromagnetism is a completely different then ferromagnetism, and so an anti-ferromagnetic alloy would not be accurately described as "semi-ferromagnetic." The examiner believes that the semi-ferromagnetic term is probably a result of an error in the translation of the Japanese priority documents.

5. Appropriate correction is required.

Claim Rejections - 35 USC § 112

6. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

7. Claims 3-10, 12-15, and 17-18 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. These claims utilize the term "semi-ferromagnetic." The examiner's basis for the 112 rejection (as a result of the use

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of this term) is the same as the basis set forth above for the objection to the specification.

Claim Rejections - 35 USC § 102

8. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

9. Claim 16 is rejected under 35 U.S.C. 102(b) as being anticipated by Wang et al. ("Low-Resistance spin-dependant tunnel junctions with ZrAlO_x barriers" Applied Physics Letters, Vol 79, No. 2, December 31, 2001, pages 4553-4555.

10. For the purpose of this examination the examiner interprets "semi ferromagnetic" to mean "antiferromagnetic." This interpretation is appropriate given that the specification lists known antiferromagnetic (AFM) alloys as "semi ferromagnetic" alloys.

11. Regarding claim 16, Wang et al. (Wang) teaches a magnetoresistive tunnel junction element having a tunnel barrier layer having a pinned layer on one side and a free layer on the opposite side. The pinned layer is pinned by an antiferromagnetic layer. The barrier layer is made form amorphous ZrAlO_x. Thus, Wang anticipates all of the limitations of claim 16.

Claim Rejections - 35 USC § 103

12. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and

the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

13. Claims 17-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wang as applied to claim 16 above, and further in view of Gill et al. (US6052263).
14. Wang fails to teach the use of a $Zr_xAl_{1-x}O_y$, $Ti_xAl_{1-x}O_y$, or $Nb_xAl_{1-x}O_y$ (where $0 < x < 1$ and $0 < y < 1$) film as a tunnel barrier layer in a top type magnetoresistance structure or a bottom type magnetoresistance structure having the structures required by claims 17 and 18 respectfully. The examiner notes however, that Wang specifically teaches that a $ZrAlO_x$ film exhibits better surface roughness than an AlO_x film (see abstract). As a result, tunnel junctions using $ZrAlO_x$ tunnel barrier layers exhibit lower barrier heights than those using AlO_x layers
15. Bearing this in mind, Gill teaches tunnel junctions having the classic top type structure (see figure 1) and bottom type structure (see figure 2). These structures are identical to those required by the applicant in claims 17-18, except that they do not utilize a tunnel barrier meeting applicant's claimed composition. Specifically, Gill teaches the use of Al_2O_3 as the barrier layer (column 6, lines 42-45).
16. Therefore it would have been obvious to one of ordinary skill in the art to use the $ZrAlO_x$ tunnel barrier of Wang as the barrier layer in the top type and bottom type tunnel junctions taught by Gill.
17. One would have been motivated to make this modification so as to obtain a tunnel junction with reduced barrier height.

18. Claims 1-2, 5-6, 9-11, 13, and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lin et al. (US6709767) in view of Wang et al.

19. Regarding claim 1, Lin teaches a magnetoresistive element that is sandwiched between two gap layers or a gap layer and a cap layer (see figure 3). In a specific embodiment, the magnetoresistive sensor comprises a substrate, a shield layer on the substrate, a gap layer (equivalent to applicants lower layer) on the shield layer, a seed layer on the gap layer, a pinning layer (equivalent to applicant's semi ferromagnetic layer) on the seed layer, a pinned layer (equivalent to applicant's claimed fixed magnetic layer) on the pinning layer, a spacer layer on the pinned layer, a sensing layer (equivalent to applicants claimed magnetic layer having a magnetization direction that is varied by an applied magnetic field), a cap layer (equivalent to applicants claimed upper layer) on the sensing layer, and a gap layer (also equivalent to applicants claimed upper layer) on the cap layer (see figure 3). While the magnetoresistive element shown in figure 3 is the so-called "bottom type" magnetoresistive element (where the pinning layer and pinned layer is located at the bottom of the structure), Lin specifically states that magnetoresistive elements having other configurations are suitable (column 5, lines 50-55).

20. Both the cap and the gap layers are made from in situ oxidized metal films, such as AlO_x or ZrO_x (column 3, lines 35-48m column 4, lines 18-15, and column 6, lines 55-60).

21. Lin fails to teach a magnetoresistive element having a lower layer formed of amorphous $\text{Zr}_x\text{Al}_{1-x}$ or $\text{Zr}_x\text{Al}_{1-x}\text{O}_y$ (where $0 < x < 1$ and $0 < y < 1$), as required by claim 1.

22. However, Wang teaches that amorphous ZrAlO_x films are useful in magnetoresistive elements, and have a smoother surface than ZrO_x and AlO_x films (see abstract).

23. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to substitute the ZrAlO_x film taught by Wang for the ZrO_x or AlO_x films taught by Lin, so as to obtain cap layers and gap layers exhibiting improved surface smoothness.

24. While the examiner acknowledges that the ZrAlO_x film of Wang is a barrier layer, one of ordinary skill in the art would still be motivated to substitute this film for the ZrO_x and AlO_x cap and gap films taught by Lin in order to obtain cap and gap layers of improved surface roughness. First, as noted by Lin, the Gap layer plays an important role in the specular scattering of electrons in the magnetoresistive element (column 7, lines 5-11). It is well known in the art of magnetoresistive elements that smoother layers exhibit improved specular scattering of electrons. Second, it is known that magnetoresistive thin films are formed via sputtering or chemical vapor deposition, which means that in most cases, the films are epitaxially grown over one another. Thus, the surface roughness of a lower film, say the lower gap layer in Lin, will be transmitted to the layers subsequently grown on it. This is known to be very undesirable, as it will increase the roughness of the barrier layer/spacer layer, thereby reducing the magnetoresistance ratio of the element. Thus, one of ordinary skill in the art would recognize the advantage of using smoother cap/gap layers in Lin, and would have been

motivated with a reasonable expectation of success in modifying the Lin reference per the teachings of Wang.

25. Thus, all of the limitations of claim 1 are met.

26. Lin as modified by Wang above meets all of the limitations of claim 2.

27. Lin as modified by Wang above meets all of the limitations of claims 5 and 6 as set forth above.

28. Regarding claims 9-10, Lin teaches that the magnetoresistive element can be a tunnel junction (column 11, lines 10-17). One of ordinary skill in the art would recognize from this statement that the spacer layer disclosed in figure 3 would be an insulative layer, and would be referred to as a tunnel barrier layer. Thus, Lin as modified by Wang meets all of the limitations of claims 9-10.

29. Claims 11, 13 and 15 are met as set forth above for claims 1, 6 and 9-10.

30. Claims 3-4, 7-8, 12, and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lin as modified by Wang as applied to claims 1-2, 5-6, 9-11, 13, and 15 above, and further in view of Gill et al. (US6052263).

31. Lin as modified by Wang fails to teach the structure of the magnetoresistive element required by claims 3-4, 7-8, 12, and 14. Specifically, Lin as modified by Wang fails to disclose a magnetoresistive element, particularly a tunnel junction, having a spacer/tunnel barrier layer on a ferromagnetic layer (free layer), a pinned layer on the spacer layer, and a pinning layer (AFM layer) on the pinning layer. However, the examiner once again notes that while the magnetoresistive element shown in figure 3 of

Lin is the so called "bottom type" magnetoresistive element (where the pinning layer and pinned layer is located at the bottom of the structure), Lin specifically states that magnetoresistive elements having other configurations are suitable (column 5, lines 50-55).

32. Bearing this in mind, Gill teaches that tunnel junctions having the so-called "top type" structure (having the structure: free/spacer/pinned/AFM) and the so-called bottom type structure (having the structure: AFM/spacer/pinned/free) are well known.

33. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to substitute a top type tunnel junction for the bottom type tunnel junction used in Lin as modified by Wang, as the prior art recognizes the equivalency of these structures.

34. As a result of this modification, all of the limitations of claims 3-4, 7-8, 12, and 14 are met.

Relevant Prior Art

35. The examiner notes that US2004/0184199 to Nakashio is relevant prior art to the instant application but does not read on the instant claims. Specifically, Nakashio teaches tunnel junction structures sandwiched between AlZr layers. The reference does not teach the use of ZrAl oxides, and does not teach the AlZr alloy is amorphous. Further, there is no motivation in the prior art to modify this reference so as to arrive at the instantly claimed invention.

Conclusion

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Any inquiry concerning this communication or earlier communications from the examiner should be directed to Nikolas J. Uhler whose telephone number is 571-272-1517. The examiner can normally be reached on Mon-Fri 7:30 am - 5 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Deborah Jones can be reached on 571-272-1535. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).


Nju


D. S. NAKARANI
PRIMARY EXAMINER